Cyber-Physical Data Cloud Computing for Real-world Awareness

Kyoungsook Kim

(ksookim@nict.go.jp)

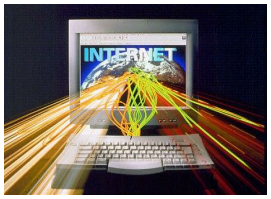
Information Services Platform Laboratory

Universal Communication Research Institute

National Institute of Information and Communications

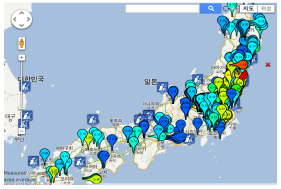
Requirement 8: Collaborative parallel strategic "future cloud" development initiatives

Lessons learned from the *Great East Japan Earthquake*



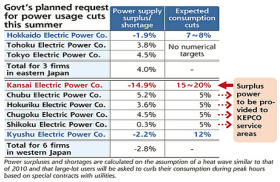
Information/communication infrastructures

Damaged physical infrastructures



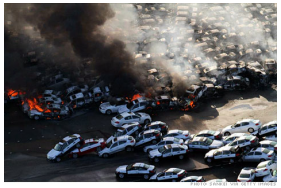
Environment issues

Health care services



Energy issues

(d-)Government services



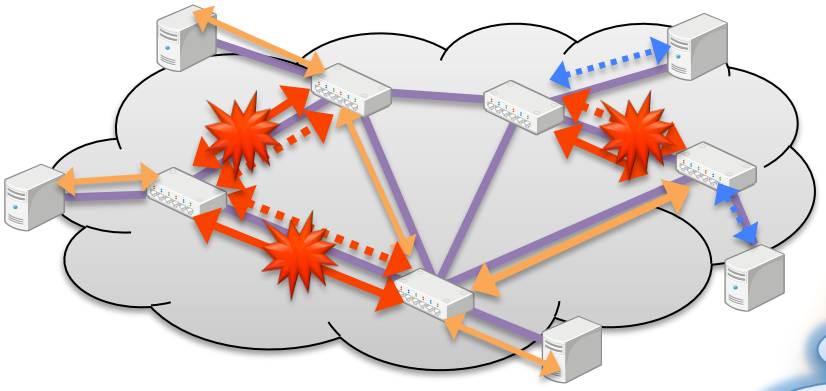
Economic issues

Rebuilding(recovery) of Physical World

Increasing of Interaction

Rebuilding(reconfigure) of Digital World

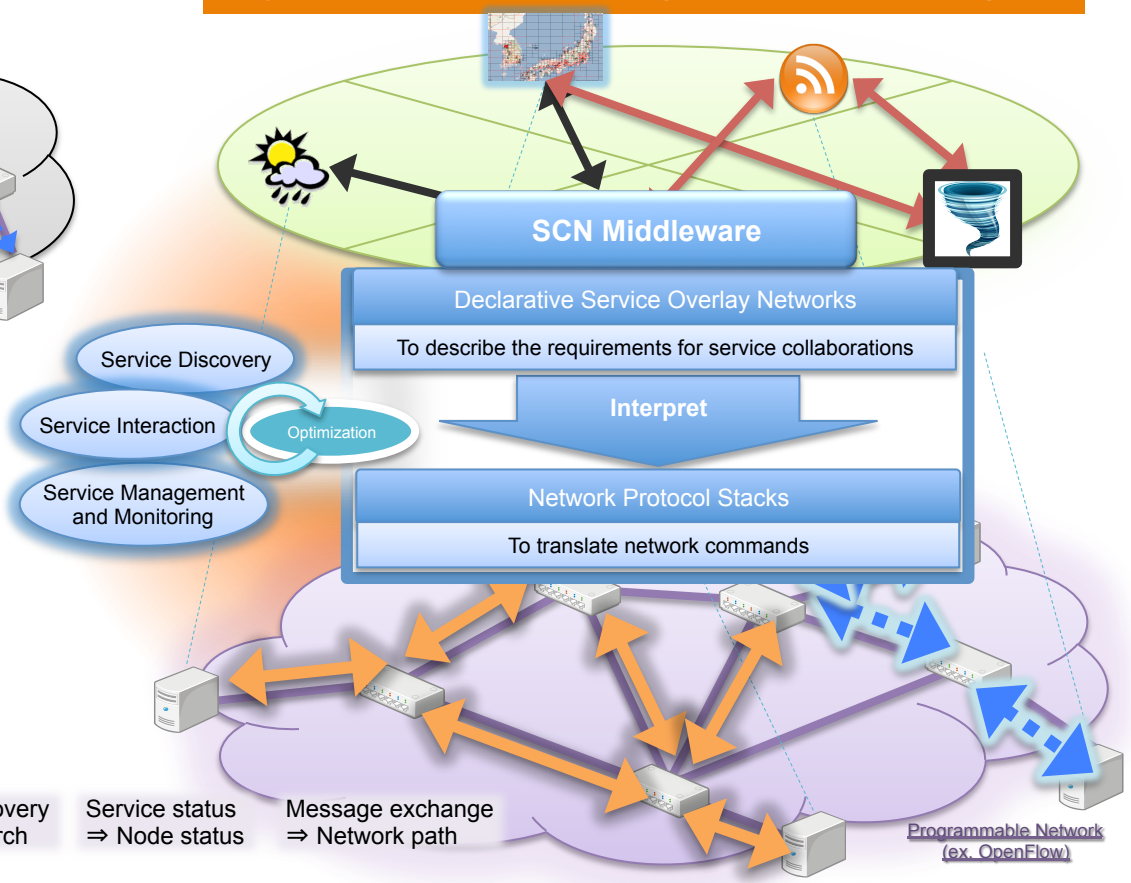
Issue & Practice: Network Reconfiguration



Rebuilding internet-based infrastructure

- Information (services) migration
- Physical addresses are changed
- Network configuration (ex. flow tables on switch, DNS, etc.)
- Temporary network policies (ex. routing, QoS control, etc.)

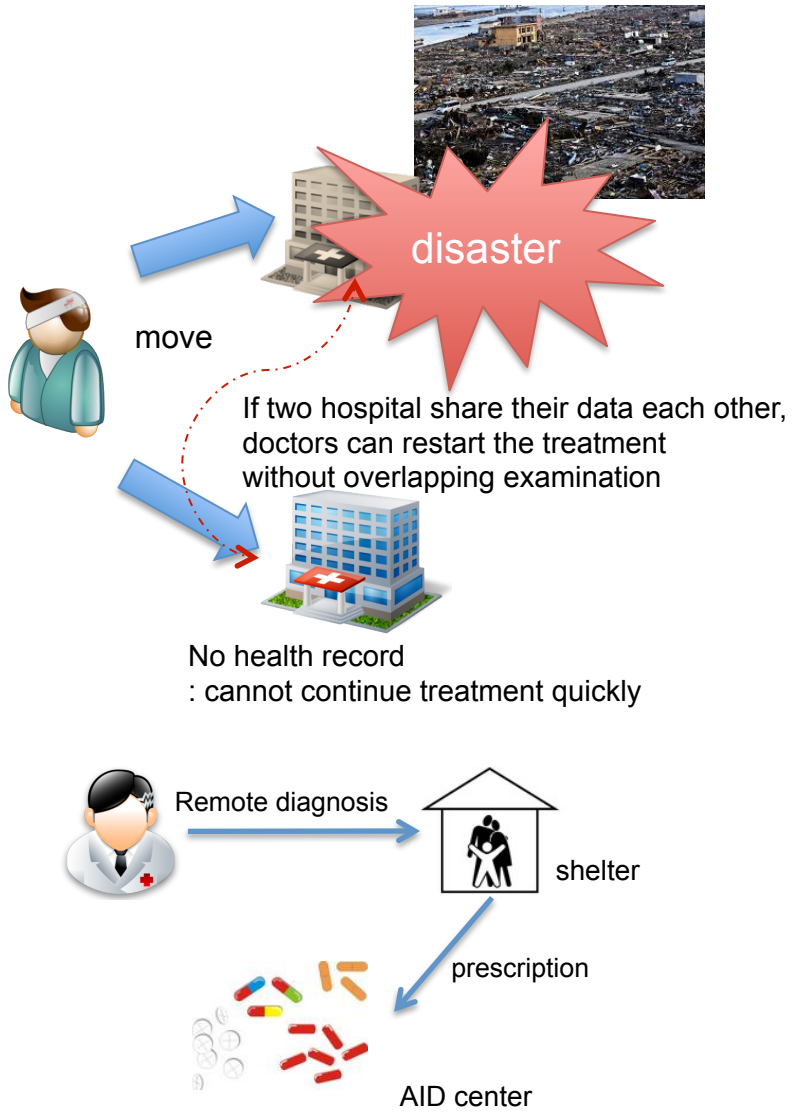
Dynamic Network Configuration Technologies

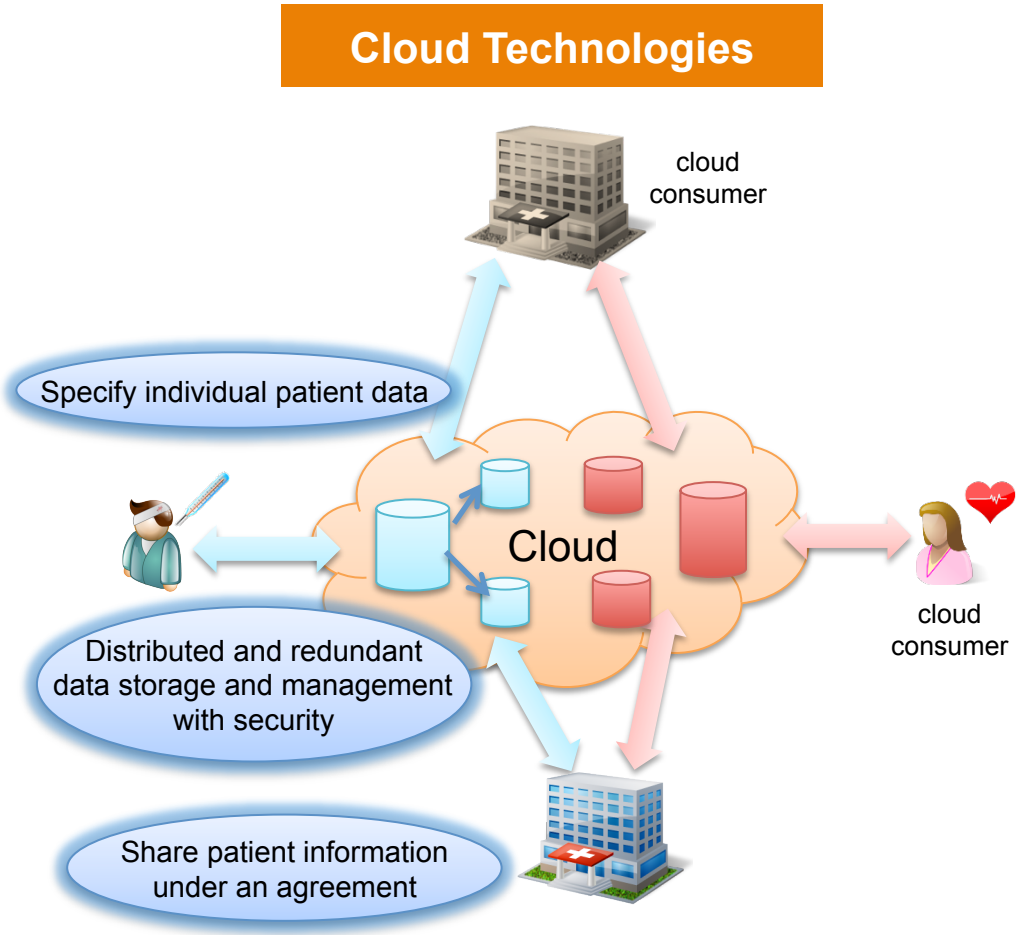


A new technology for precisely and promptly delivering information service requests (i.e., networking requirements) to networks and dynamically adjusting network configurations without much operational cost on the basis of the New Generation Networks

(source) NICT NWGN Service-Controlled Networking

Issue & Practice: Health Care Services





Issue & Practice: Energy Policy Control

Japan energy policy after Fukushima

→ **A nuclear-free society**

However, not enough energy power

→ **Power saving**

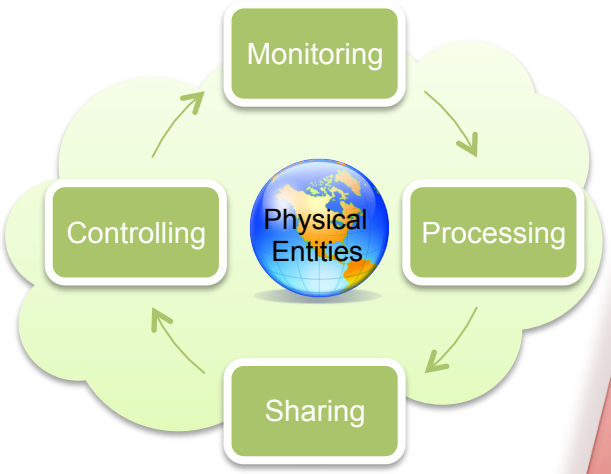
ex.) Kansai area have to reduce electricity consumption in the upcoming summer about 15~20 percent from 2010 levels

Smart Grid Technologies

Electrical grid that gathers, distributes, and acts on information about the behavior of all participants (suppliers and consumers) for the efficiency, importance, reliability, economics, and sustainability of electricity services (*from wikipeida*)

(source) EPRI Smart Grid

Real-world Awareness



Cyber-Physical Cloud Computing

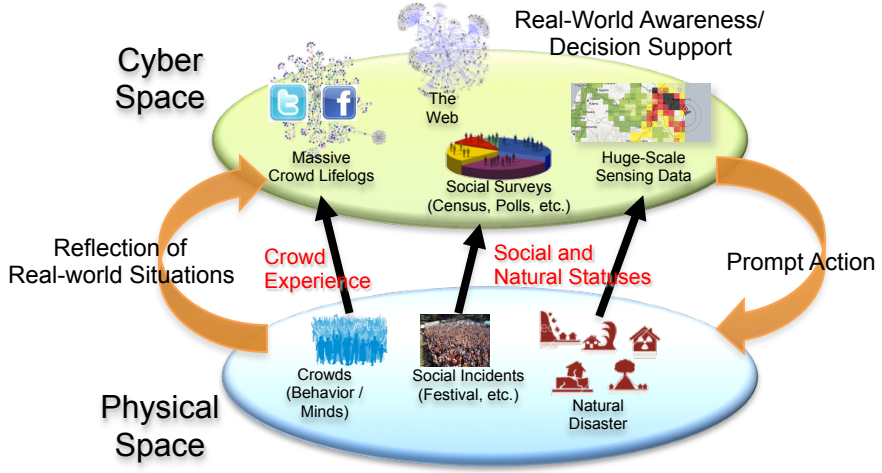
Intelligent cyber technologies that can be rapidly and autonomously modified and provisioned to meet changing needs depending on history and present circumstances of physical entities

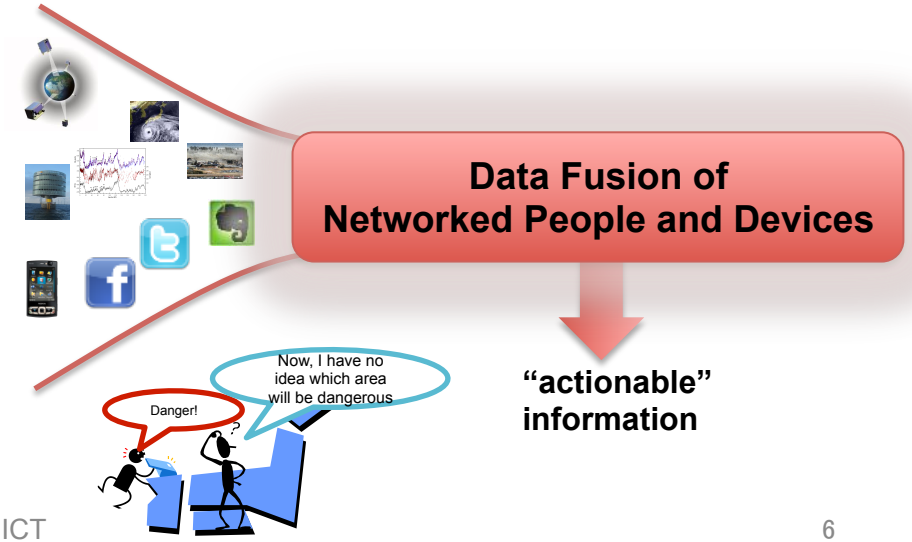
- Resiliency
- **Inter-Situational Intelligence**
- **Accurate and Reliable Information**
- Privacy and Security
- **Nation-scale**

[Reinforced Requirements]

On demand self service
Broad network access
Resource pooling
Rapid elasticity
Measured service

How can we evaluate situational information and deliver actionable information that is relevant to a particular decision?

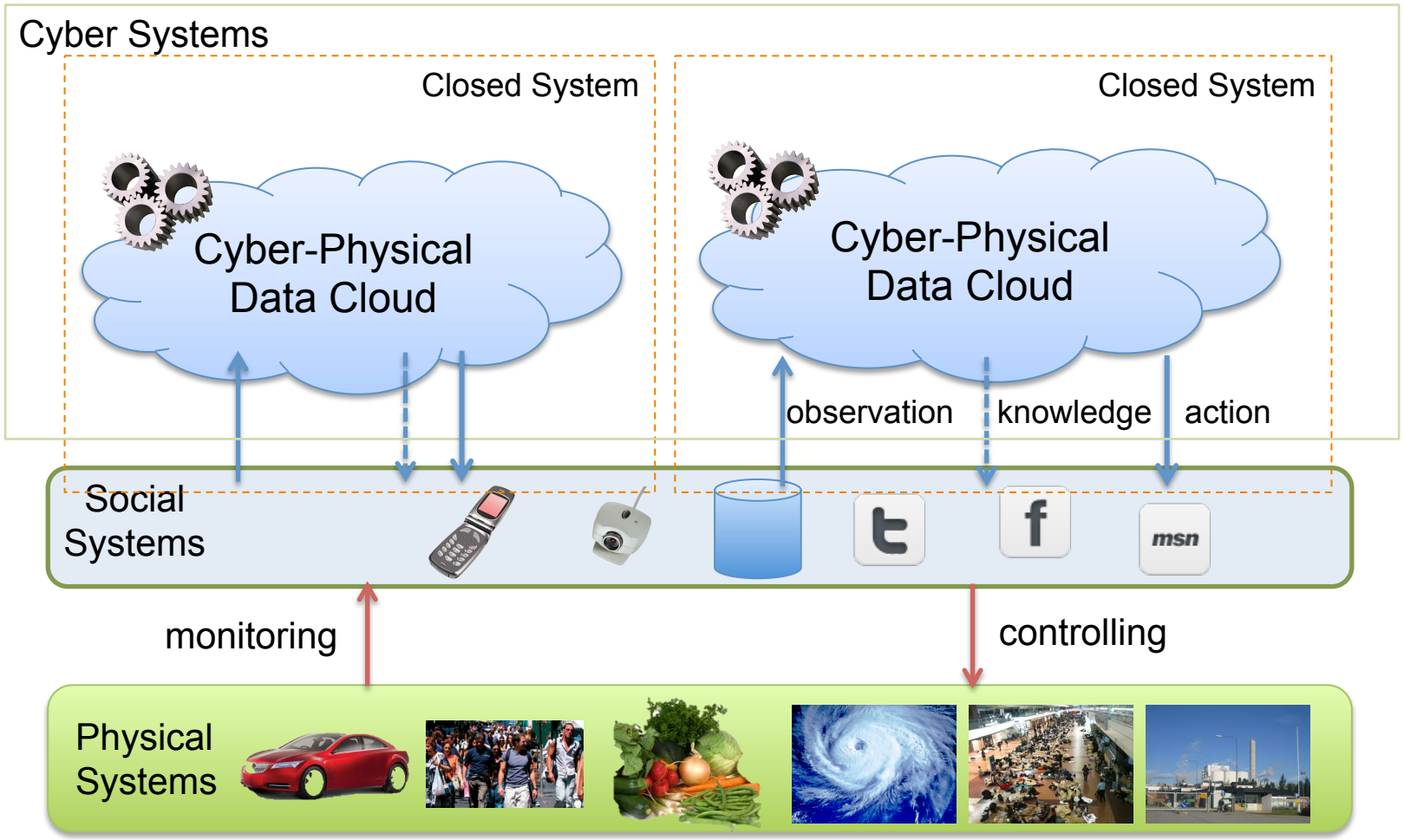




Cyber-Physical Data Cloud (CPDC) Project

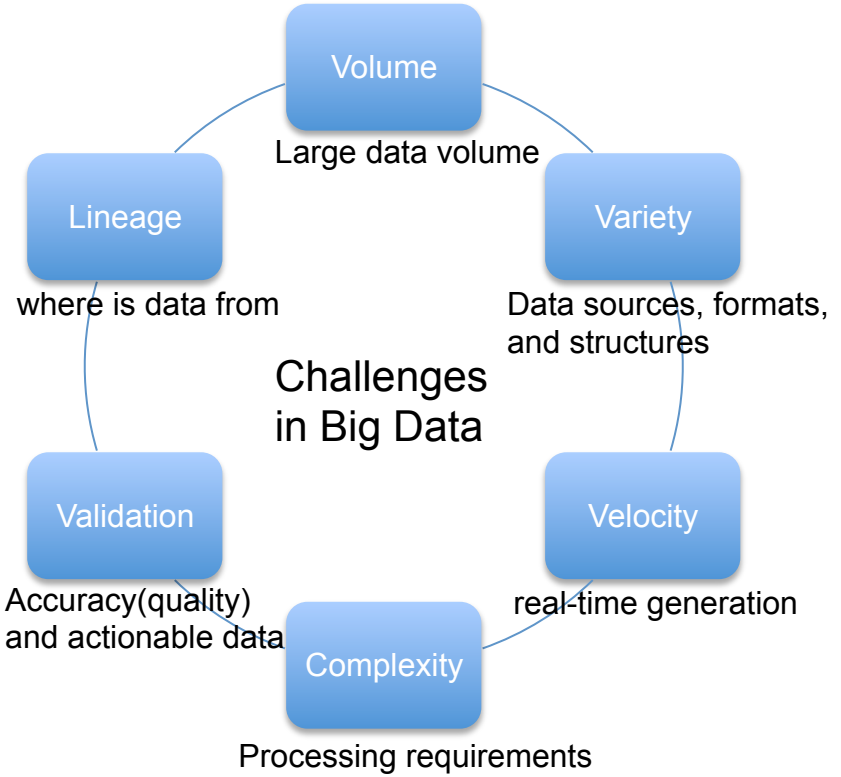
NIST and NICT collaboration project

- R&D for collecting, archiving, manipulating, organizing, and sharing very large (big) cyber-physical social data



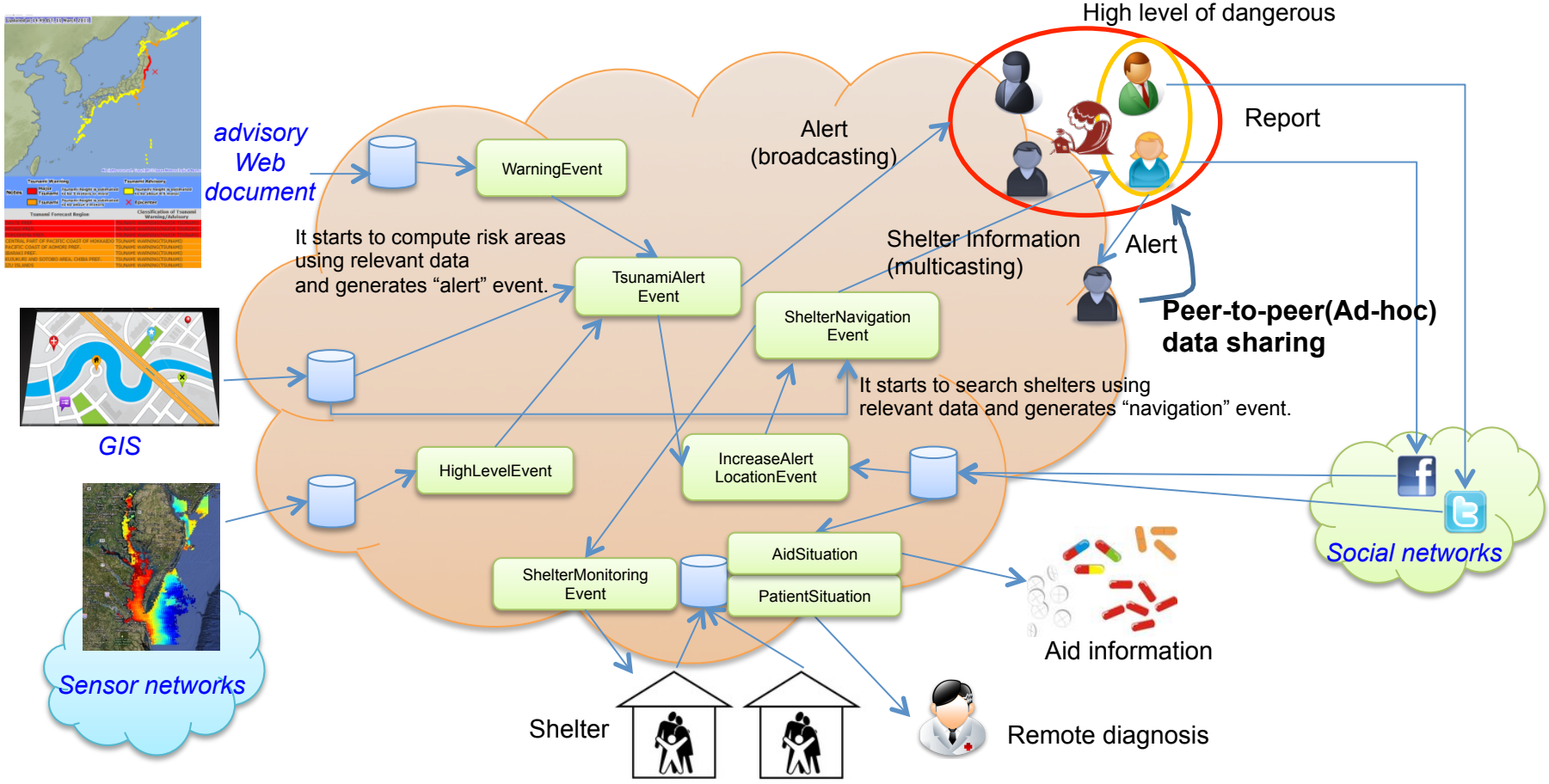
Main Supports (Considerations)

- Social & Sensor Data Integration
  - Big data handling
  - Agile operations
- **Inter-connection**
  - Being aware of relationships between elements(objects, events, situations) based on heterogeneous data sets
- **Delivery(Sharing) of Actionable Information**



Use Case: Geo-fencing

Globally monitoring and locally fencing (safe and rapid evacuation)

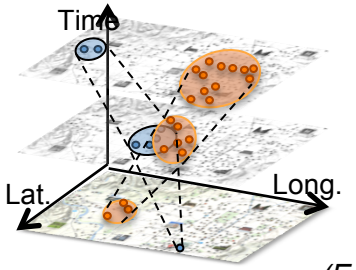


Event-based Data Management

- Search multi-domain data sets for heterogeneous events correlating with query event

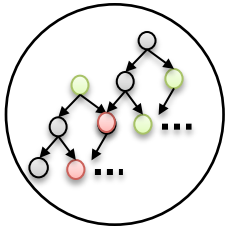
Event Correlations

Spatiotemporal



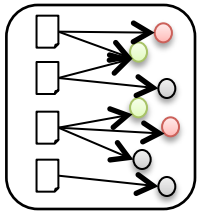
(E.g.) Intersectional areas between disaster and rumor

Ontological

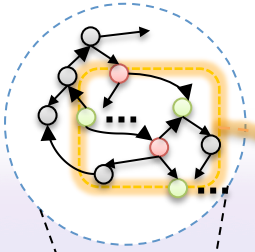


(E.g) Relations between disaster and healthcare based on codified experiences

Citational



(E.g.) Natural phenomena referred from radiation science articles

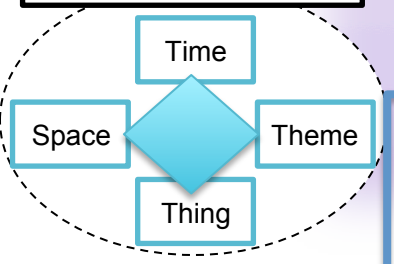


Ex.) Hurricane -> traffic, healthcare, accidents, etc

Complex Join

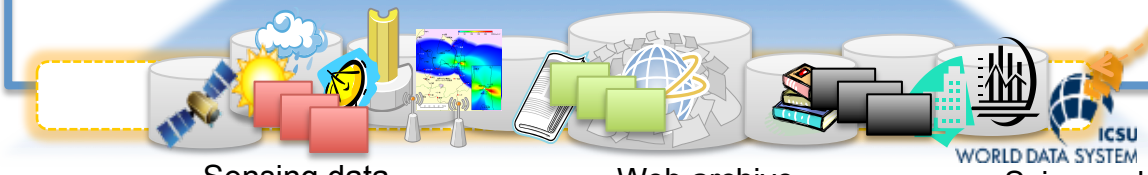
Accidents | Weather | Disasters | Natural Phenomena | Traffic | .....

Event Metadata



Cross-Data Search Engine

Event Metadata Extraction



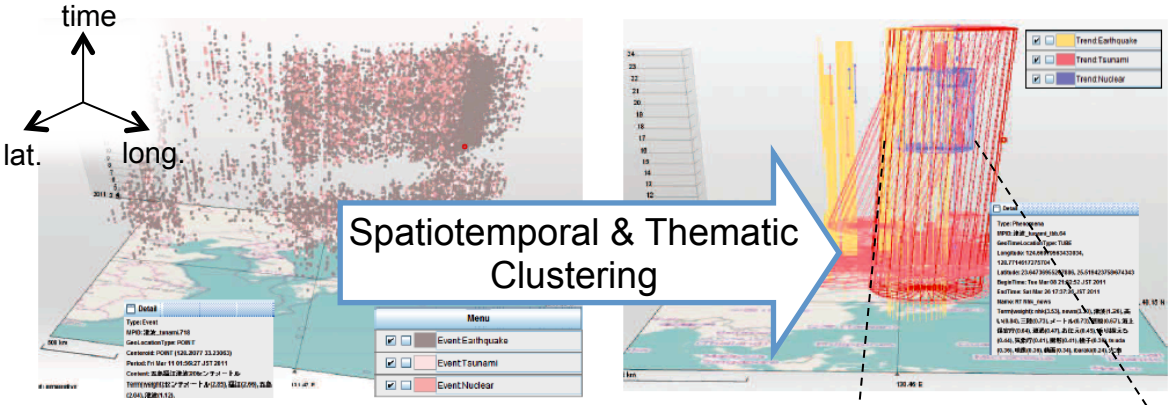
Multi-domain, Heterogeneous Datasets

Sensing data | Web archive | Science data

Cyber-Physical Data Visualization

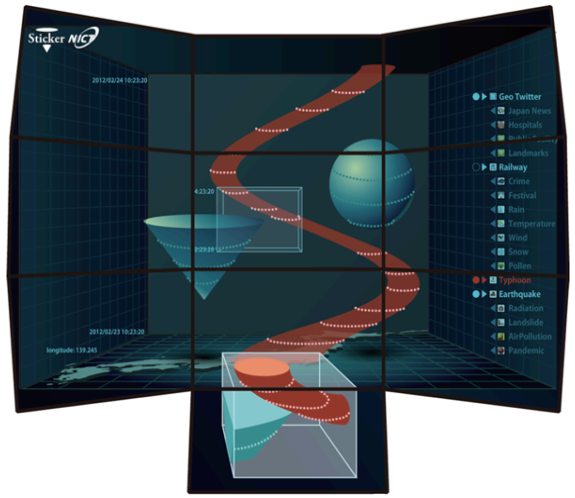
- Mapping and clustering event metadata of cyber data and physical data
  - Cyber data: online documents, Web pages, blogs, SNS
  - Physical data: observation data
- Visual data mining for discovering relations between natural phenomena and social phenomena
  - *E.g.) Baby milk shortage in surrounding area of earth quake along with radiation spread.*

STICKER: **S**patio**T**emporal **I**nformation **C**lustering and **K**nowedge **Ext**R**actor**



Mapping and clustering: (2011/03/02-2011/03/24)
1) earthquake data,
2) tsunami data,
3) nuclear radiation data,
4) geo-tagged Tweets of Tohoku Earthquake Disaster

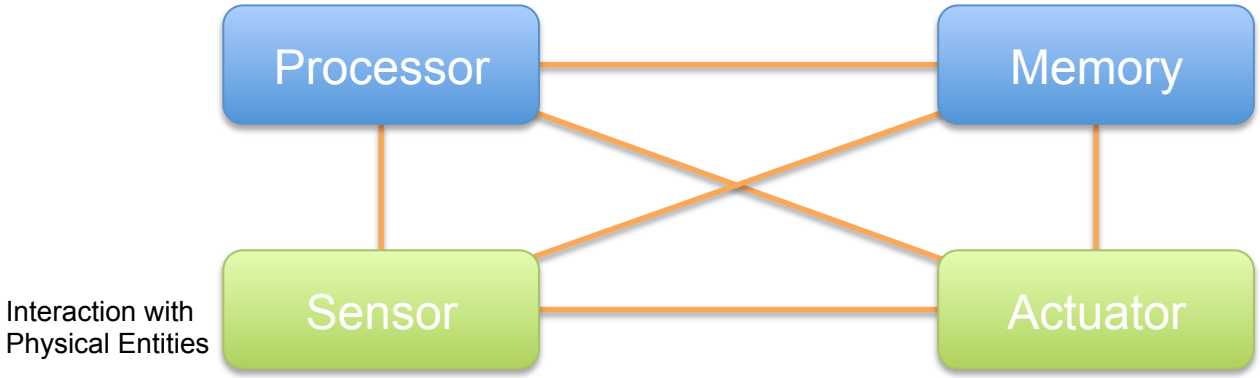
Twitter keywords in overlapped area



STICKER 3D – Interactive visual data mining using 3D 10-tiled display windows (under development)

CPDC Architecture

- Working on…



- Cyber-Physical Data Services
  - **Observation** as a Service
  - **Knowledge** as a Service
  - **Action** as a Service

Representation/Storage Model

Processing Model

Collaboration Model

Thank you for your attention!